Cubesat Mission: Low Mass Radio Science Transponder

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Project Objective:

Demonstrate that JPL can produce a low mass radio science transponder for a nanosat-class mission for costs usually associated with small technology development tasks.

Phase One: (DRDF Funding) Repackage Radio Science Transponder Instrument (RSTI) into Low Mass Radio Science Transponder (LMRST) in Cubesat prescribed form factor. Mate LMRST with Cubesat. Perform integrated testing.

Phase Two: (Funds pending) Place the nanosat in or near earth orbit to provide a calibration source for DSN.

FY09 Results:

- Repackaged X-Band RSTI to Cubesat prescribed mechanical configuration.
- Met Cubesat prescribed mechanical and electrical interfaces.
- Procured 1-U Cubesat satellite "bus" from Pumpkin, Inc.
- Teamed with Stanford AA236 satellite design graduate class and Space Systems Development Lab (SSDL).
    - mission design including power, thermal, and operational constraints
    - flight software
    - command and telemetry including eight LMRST telemetry points and on/off control
- Integrated Testing
    - VHF / UHF (command / telemetry) antenna deployment demonstration
    - mechanical and electrical integration
    - Command and telemetry demonstration over VHF / UHF radios and over USB.
    - LMRST demonstrated carrier lock and 880 / 749 transponder turn-around ratio at expected signal levels.
    - Delivery of Cubesat and complete Phase One documentation to JPL.

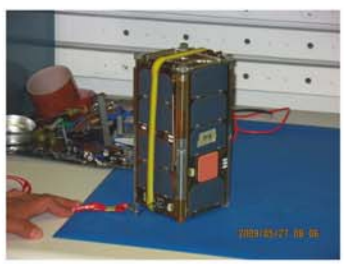
Benefits to NASA and JPL:

The ability to test or employ small, individual instruments in space at costs orders of magnitude below that of traditional missions is a revolutionary growth area in aerospace. This work demonstrates what is possible for this class of very small spacecraft on modest budgets.

Any instrument or payload of one or two liters volume and up to one or two kilograms mass can be hosted on a small bus in this way and placed in orbit as a student project for under a million dollars if the rideshare program within the Cubesat community is utilized. At one kilogram and eight watts, LMRST is the heaviest and highest power payload ever implemented for a Cubesat and is adequately accommodated in the mission design. Two or three watts orbit-average power enables this experiment at eight watts by time sharing with the telemetry transmitter and activating the payload only when needed. A higher orbit and/or larger "3-U" design would provide more power and operating time.

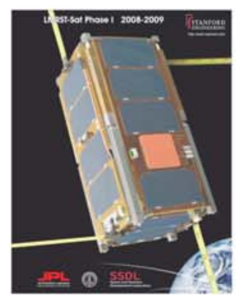
JPL's interest in small demonstration class missions of this sort is synergistic with the Cubesat community's interest in expanding toward deep space missions.

Stacked Cubesat bus and LMRST



Stack with simulated solar panels and X-Band patch. Pre-deployed VHF/UHF antennas.

Satellite during command / telemetry demonstration with antennas deployed.



Phase One Final Product

Web-based Telemetry Display

Team Members:

These SSDL / AA236 students directly participated in integrated testing at JPL: Kevin Anan Stein (student leader), Yonas Tesfaye, Dhackson Muthulingam, Bryan Lin, Joseph Johnson, and Edward Truong-Cao. Other SSDL AA236 student participants were Stephen Pifko, Nicolas Lee, Cyrus Foster, Randy Lum, Dawn Wheeler, Kevin Brown, Brian Thompson, Steve Brinkman, Michael Rhaney, Mark Vallee, Kim Shish, Julian Mann, and Avishai Weiss. JPL LMRST team: Fernando Aquirre, Mike Settember, Amy Boas, Armond Matevosian, Jim Shell, Narayan Mysoor, Raymond Quintero, Kathleen Sowles, and Salman Haque.

Publication:

Courtney Duncan, Matt Dennis, Andrew Kalman, Kevin Anand Stein, Yonas, Tesfaye, Bryan I-Ming Lin, Eddie Truong-Cao, and Cyrus Foster, "LMRST-Sat: A Small, High Value-to-Cost Mission." Accepted for IEEE Aerospace Conference, Big Sky Montana, March 2010.

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Poster No. 09-151